ILRS SLR MISSION SUPPORT REQUEST FORM (version: April, 2016)

SUBMISSION STATUS:

- (●) New Submission (default)
- ( ) Incremental Submission (accepted only for a follow-on mission; fill-in new information only)

(provide the reference mission and the date approved by the ILRS: ________________________)

SECTION I: MISSION INFORMATION:

General Information:

Satellite Name: S-NET

Satellite Host Organization: Technische Universität Berlin

Web Address: www.space.tu-berlin.de/menue/forschung/aktuelle_projekte/s_net/parameter/en/

Contact Information:

Primary Technical Contact Information:

Name: Dr. Zizung Yoon

Organization and Position: Technische Universität Berlin, project manager

Address: Marchstrasse 12-14, 10587 Berlin

Phone No.: +49 30 314 24438

E-mail Address: zizung.yoon@ilr.tu-berlin.de

Alternate Technical Contact Information:

Name: Walter Frese

Organization and Position: Technische Universität Berlin, system engineer

Address: Marchstrasse12-14,10587Berlin

Phone No.: +49 30 314 25611

E-mail Address: walter.frese@ilr.tu-berlin.de

Primary Science Contact Information:

Name: Dr. Zizung Yoon

Organization and Position: Technische Universität Berlin, project manager

Address: Marchstrasse12-14,10587Berlin

Phone No.: +49 30 314 24438

E-mail Address: zizung.yoon@ilr.tu-berlin.de

Alternate Science Contact Information:

Name: Walter Frese

Organization and Position: Technische Universität Berlin, system engineer

Address: Marchstrasse12-14,10587Berlin

Phone No.: +49 30 314 25611

E-mail Address: walter.frese@ilr.tu-berlin.de

Mission Specifics:

Scientific or Engineering Objectives of Mission:
(specify)

mission statetment is: demonstration of S-band intersatellite communication based on a network of four nanosatellites
mission objectives are:
1. demonstration of multipoint intersatellite communication
2. verification of communication protocols
3. analysis of nanosatellite formation
4. demonstration of feasibilty of nanosatellite platform for communication purpose

Role of Satellite Laser Ranging (SLR) for the Mission:
(specify)

1. The laser ranging should support the intersatellite communication experiments by determining the relative distance and correlating with the transceiver signal travel time.
2. Four satellites are deployed with interval of 10s from upper stage with a high precision mechanism. The deployment parameters (distribution of velocity and direction) shall be verified by analyzing SLR data.
3. The orbital drift behaviour of the constellation shall be analyzed in the early orbit insertion phase to propagate the formation drift.

Anticipated Launch Date: Dec. 2017

Expected Mission Duration: 1 Year

Required Orbital Accuracy: < 1m

Anticipated Orbital Parameters:

Altitude (Min & Max for eccentric orbits): 600 km

Inclination: 97.6 - 97.9 degrees

Eccentricity: 0

Orbital Period: 96.7 min

Frequency of Orbital Maneuvers: -

Mission Timeline:
(example)
Should include when SLR is to start within the mission timeline, such as "on insertion into orbit" or "launch +N" days.

SLR should start on insertion into orbit (four satellites are deployed with 10s interval radial to flight direction). Since then the four satellites will passively drift apart while performing communication experiments for 4-6 monthes.

Tracking Requirements:

Tracking Schedule: ◉ horizon-to-horizon ○ custom (specify: ____________)

Spatial Coverage: ◉ global ILRS network ○ custom (specify: ____________)

Temporal Coverage: ◉ full-time ○ custom (specify: ____________)

Normal Point Bin Size (Time Span): 5 seconds

(Choose one from 5, 15, 30, 120 and 300 seconds. Justify if other bin size is required.)
(See the "Bin Size" of other satellites on the ILRS Web site at
http://ilrs.gsfc.nasa.gov/missions/satellite_missions/current_missions/index.html .)

Prediction Center: Technische Universität Berlin

Prediction Technical Contact Information:

Name: Dr. Zizung Yoon

Organization and Position: project manager

Address: Marchstrasse 12-14, 10587 Berlin

Phone No.: +49 314 24438

E-mail Address: zizung.yoon@ilr.tu-berlin.de

Priority of SLR for POD: ◉ Primary ○ Secondary ○ Backup

Other Sources of POD:

☐ GNSS ☐ DORIS ☐ Accelerometer ☐ other (specify: ____________)

Other comments on mission information:

(specify) (list backup prediction centers and references/links to non-SLR techniques if available)

Additional relative distance measurment among satellites is performed by measuring signal delay of intersallite communication

SECTION II: TRACKING RESTRICTIONS:

Several types of tracking restrictions have been required during some satellite missions. See *http://ilrs.gsfc.nasa.gov/satellite_missions/restricted.html* for a complete discussion.

1) Elevation restrictions: Certain satellites have a risk of possible damage when ranged near the zenith. Therefore a mission may want to set an elevation (in degrees) above which a station may not range to the satellite.
2) Go/No-go restrictions: There are situations when on-board detectors on certain satellites are vulnerable to damaged by intense laser irradiation. These situations could include safe hold position or maneuvers. A small ASCII file is kept on a computer controlled by the satellite's mission which includes various information and the literal “go” or “nogo” to indicate whether it is safe to range to the spacecraft. Stations access this file by ftp every 5-15 minutes (as specified by the mission) and do not range when the flag file is set to “nogo” or when the internet connection prevents reading the file.
3) Segment restrictions: Certain satellites can allow ranging only during certain parts of the pass as seen from the ground. These missions provide station-dependent files with lists of start and stop times for ranging during each pass.
4) Power limits: There are certain missions for which the laser transmit power must always be restricted to prevent detector damage. This requires setting laser power and beam divergence at the ranging station before and after each pass. While the above restrictions are controlled by software, this restriction is often controlled manually.

Many ILRS stations support some or all of these tracking restrictions. You may wish to work through the ILRS with the stations to test their compliance with your restrictions or to encourage additional stations that are critical to your mission to implement them.

The following information gives the ILRS a better idea of the mission's restrictions. Be aware that once predictions are provided to the stations, there is no guarantee that forgotten restrictions can be immediately enforced.

Are there any science instruments, detectors, or other instruments on the spacecraft that can be damaged or confused by excessive radiation, particularly in any one of these wavelengths (532nm, 1064nn, 846nm, or 432nm)?

◉ No ○ Yes (specify the instrument or detector in question, providing the wavelength bands and modes of sensitivity.)

Are there times when the LRA (Laser Retroreflector Array) will not be accessible from the ground?

◉ No ○ Yes (specify: ________________________________

(If so, go/nogo or segmentation files might be used to avoid ranging an LRA that is not accessible.)

→ Skip the next questions and go directly to SECTION III if you answered “No” to both of the above questions.

Is there a need for an elevation tracking restriction?

○ No ○ Yes (What elevation (minimum to maximum in degrees)? _________ degrees)

Is there a need for a go/no-go tracking restriction?

○ No ○ Yes (Explain the reason(s) ____)

Is there a need for a pass segmentation restriction?

○ No ○ Yes (Explain the reason(s) ____)

Is there a need for a laser power restriction?

○ No

○ Yes (Under what circumstances? ____)

(What is the maximum permitted power level **at** the satellite (nJ/cm^2)? __________)

(Is manual control of laser transmit power acceptable? ○ Yes ○ No)

For ILRS stations to range to satellites with restrictions, the mission sponsor must agree to the following statement:

"The mission sponsor agrees not to make any claims against the station or station contractors or subcontractors, or their respective employees for any damage arising from these ranging activities, whether such damage is caused by negligence or otherwise, except in the case of willful misconduct."

Please provide signature to express agreement to above statement:

Signature: ____

Date: __________________________

Name (print): ____

Organization and Position: ____

Other comments on tracking restrictions:
(specify)

SECTION III: RETROREFLECTOR ARRAY INFORMATION:

A prerequisite for accurate reduction of laser range observations is a complete set of pre-launch parameters that define the characteristics and location of the LRA on the satellite. The set of parameters should include a general description of the array, including references to any ground-tests that may have been carried out, array manufacturer and whether the array type has been used in previous satellite missions. So the following information is requested:

Retroreflector Primary Contact Information:

Name: Dr. Zizung Yoon

Organization and Position: Technische Universität Berlin

Address: Marchstrasse 12-14, 10587 Berlin

Phone No.: +4931424438

E-mail Address: zizung.yoon@ilr.tu-berlin.de

Array type:

○ Single reflector ○ Spherical ○ Hemispherical/Pyramid ◉ Planar

○ other (specify: ________________)

Attach a diagram or photograph of the satellite that shows the position of the LRA, at the end of this document.

☒ Attached

Attach a diagram or photograph of the whole LRA at the end of this document.

◉ Attached ○ Same as above, Not attached (acceptable only for a cannonball satellite)

Array manufacturer:

Hengrun Optoelectronics tech co. Ltd.

Link (URL and/or reference) to any ground-tests that were carried out on the array:

see attachment

Has the LRA design and/or type of cubes been used previously?

○ No ◉ Yes (List the mission(s): "Technosat" of Techn. Univ. Berlin)

For accurate orbital analysis it is essential that full information is available in order that the 3-dimensional position of the satellite center of mass may be referred to the location in space at which the laser range measurements are made. To achieve this, the 3-D location of the LRA phase center must be specified in a satellite-body-fixed reference frame with respect to the satellite's mass center. In practice this means that the following parameters must be available at 1 mm accuracy or better.

Define the satellite-body-fixed XYZ coordinates (i.e. origin and axes) on the spacecraft:
(specify) (add a diagram in the attachment)

origin is the geometric center (see diagram for directions)
X+: nominal flight direction
Y+:
Z+: up-/downlink s-band antenna, UHF antenna, direction of corner cube pattern

Relate the satellite-body-fixed XYZ coordinates to a Celestial/Terrestrial/Solar Reference Frame including the attitude control policy:
(specify) (add a diagram in the attachment)

during nominal operation: nadir pointing
during downlink: ground station pointing
x: flight direction
y: anti orbit momentum vector
z: nadir

The 3-D location of the satellite's mass center in satellite-body-fixed XYZ coordinates is:

- ○ Always fixed at (0, 0, 0)
- ◉ Always fixed at (8.88, 2.44, -5.56) in mm
- ○ Time-varying by approximately (______________) mm during the mission lifetime.
  Will a time-variable table of the mass center location be available on the web?
  ○ No ○ Yes (URL: ____)

The 3-D location (or time-variable range) of the phase center of the LRA in the satellite-body-fixed XYZ coordinates:

(___________, ___________, ___________) in mm

The following information on the corner cubes must also be supplied.

The XYZ coordinates referred to in the following are given in:

- ◉ Satellite-body-fixed system (same as above)
- ○ LRA-fixed system (specify below)

(specify the origin and orientation) (add a diagram in the attachment)

List the position (XYZ) of the center of the front face of each corner cube, and the orientation (two angles or normal vector) and the clocking (horizontal rotation) angle of each corner cube. Note that the angles should be clearly defined.

- [x] Attached at the end of this document
- [ ] Listed here (acceptable for small number (10 or fewer) of corner cubes)

(specify) (add a diagram in the attachment)

Is the corner cube recessed in its container (i.e. can the container obscure a part of the corner cube)?

- [x] No
- [ ] Yes (specify below)

(specify) (add a diagram)

The size of each corner cube: Diameter (10) mm Height (7.5) mm

The material from which the cubes are manufactured (e.g. quartz):

fused silica

The refractive index of the cube material

= 1.461 for wavelength $\lambda = 0.532$ micron

= __________ as a function of wavelength λ (micron):

The group refractive index of the cube material, as a function of wavelength λ (micron):

= 1.485 for wavelength $\lambda = 0.532$ micron

= __________ as a function of wavelength λ (micron):

Dihedral angle offset(s) and manufacturing tolerance (in arcseconds):
no offset: manufacturing accuracy: +/-3 arcsec

Radius of curvature of front surfaces of cubes:

◉ Not applied ○ Yes (specify: ________________)

Flatness of cubes' surfaces:
not specified

Back-face coating:

○ Uncoated ◉ Coated (specify the material: silver coating with black protective paint)

Other comments on LRA:

(specify) (add a reference to a study of the optical response simulation/measurement if available) (add a diagram if applicable)

L. Grundwaldt, R. Neubert, M.F. Barschke, 'Optical tests of a large number of small COTS cubes', 20th International Workshop on Laser Ranging, Germany 2016

G. Kirchner, L. Grundwaldt, R. Neubert, F. Koidl, M. Barschke, Z. Yoon and H. Fiedler, 'Laser ranging to nano-satellites in LEO orbits: plans, issues, simulations', 18th International Workshop on Laser Ranging, Japan 2013

SECTION IV: MISSION CONCURRENCE

As an authorized representative of the S-NET mission, I hereby request and authorize the ILRS to track the satellite described in this document.

Name (print): Prof. Dr. -Ing. Klaus Briess

Organization and Position: Technische Universität Berlin, Head of Chair

Signature:

Technische Universität Berlin
Institut für Luft- und Raumfahrt
Sekr. F6
Marchstr. 12 · D-10587 Berlin

Date: 22.06.2017

Send form to: ILRS Central Bureau
c/o Carey Noll
NASA GSFC
Code 690
Greenbelt, MD 20771
USA
301-614-6542 (Voice)
301-614-6015 (Fax)
Carey.Noll@nasa.gov

SECTION V: ATTACHMENT(S)

Attachment 1 - SNet specific information
Attachment 2 - Measurement report for 10 mm cubes, by GFZ Potsdam, Germany
Attachment 3 - Reflection trace meausurment for S-NET pattern, Austrian Academy of Sciences